

**Prevalence of depression among university students in low and middle income countries (LMICs):
a systematic review and meta-analysis**

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Abstract

Though professional college and university years are peak time for the onset of many mental health problems including depression, knowledge on the prevalence of depression among university students in low- and middle income countries (LMICs) is limited. This study examined the prevalence of depression among university students in LMICs. We systematically searched PubMed, Web of Science and WHO Global Health Library for studies published between January 1, 2009 and December 31, 2018. Cross-sectional and longitudinal studies conducted in LMICs (as defined by World Bank), having a sample size ≥ 500 and published in English language were identified. Data on study characteristics and prevalence of depression was extracted by two investigators. Prevalence estimates were pooled in meta-analysis using random-effects meta-analysis. Sub-group differences were estimated using mixed effects meta-analysis and meta-regression. Depression prevalence data were extracted from 37 included studies involving 76,608 individuals in 20 countries. Overall, studies on depression among university students in LMICs are limited, and most are based on non-representative and small study samples. The overall prevalence of depression was 24.4% (95% CI, 19.2% to 30.5%). Subgroup analysis revealed that prevalence of depression did not vary by study design, sampling technique, sample size, study major, educational level, geographical or economic regions, and depression screening instrument. Depression among university students in LMICs is a significant concern. Further research needs to include representative samples and needs to explore risk and protective factors for depression. More efforts are required for the development of mental healthcare services in LMICs.

Keywords: University Students, Depression, Prevalence, Low and Middle Income Countries, systematic review, meta-analyses

1. Introduction

Common mental disorders in low and middle income countries (LMICs) are an important global health concern. More than 80% of people with mental disorders reside in these countries (World Health Organization, 2008). LMICs not only have the majority of the world's population but also the largest proportion of youth, who are particularly vulnerable to mental health problems (Population Reference Bureau, 2019; United Nations, 2018). Youth and adolescence are crucial time periods for psychosocial development and educational attainment as a healthy adolescence paves way for a healthy and productive adulthood. This period is also critical for the onset of common mental disorders especially in educational settings such as professional colleges and universities (hereafter referred as universities). Around one-third of mental health problems have their first onset before the age of 24 which is associated with increased disability, poor educational performance and loss of productivity (Kessler et al., 2007; Mokdad et al., 2016). Studies indicate that university students report higher rates of depression than the general population with prevalence estimates ranging from 24% to 34% (Ibrahim, Kelly, Adams, & Glazebrook, 2013; Lei, Xiao, Liu, & Li, 2016; Rotenstein et al., 2016; Tam, Lo, & Pacheco, 2019; Tung et al., 2018). This high prevalence of depressive disorders is the second leading causes of years lost due to disability (YLDs) and Disability Adjusted Life Years (DALYs) in young people aged 20-24 years (Mokdad et al., 2016).

Various studies have explored causes and consequences of depression among university students. However, the academic stressors are not the sole cause of depression among the students, suggesting the role of different bio-psychosocial stressors (Hysenbegasi, Hass, & Rowland, 2005). For instance, living away from the family, concerns about future employment (X.-F. Pan et al., 2016), financial conditions (Richardson, Elliott, Roberts, & Jansen, 2017), psychological characteristics such as poor resiliency (Sun L et al., 2011), academic pressure, competitive environment and interpersonal relationships (Waqas, Khan, Sharif, Khalid, & Ali, 2015) have been found to be the contributing factors for poor mental health of university students. Several studies show an early-onset of depression is associated with several adverse consequences such as termination of education (Breslau, Lane, Sampson, & Kessler, 2008; Kessler, Foster, Saunders, & Stang, 1995; Lee et al., 2009), poor academic performance, severe role impairment and reduced employment prospects in adulthood (Alonso et al., 2018; Auerbach et al., 2016; Mojtabai et al., 2015). This diagnosis of depressive disorder is associated with lower GPA (0.49 points) (Hysenbegasi et al., 2005).

Most of the LMICs are affected by poverty, conflict and violence, that exposes university students at a greater risk of mental health disorders including depression (World Health Organization, 2002). The high prevalence of depression is further exacerbated by limited access to healthcare services, poor diagnostic and treatment seeking practices and public and self-stigma associated with it (Waqas, Zubair, Ghulam, Ullah, & Tariq, 2014). University students are future work force and have a critical role in their countries' economic growth, which is particularly important for LMICs. Therefore, the early recognition and treatment is critical for students as it can reduce the adverse impact of depression, improve the prognosis, and subsequently reduce the risk of psychosocial impairment (Ettner, Frank, & Kessler, 1997; Weitzman, 2004). It is of paramount importance to quantify the prevalence of depression among university students for resource allocation.

This study aimed to address the paucity of data and conduct meta-analysis on prevalence of depression among university students in LMICs. A majority of the previous systematic reviews have focused on medical students only (Hope et al., 2014; Pacheco et al., 2017; Rotenstein et al., 2016; Tung et al., 2018). No meta-analyses have estimated prevalence of depression among university students in LMICs, where the majority of world's youth lives battling with poverty, poor support, limited access to healthcare, conflict and violence. Understanding the burden of depression among university students in

LMICs can help in designing effective intervention programs, tailored to the needs of this population (Huang, Nigatu, Smail-Crevier, Zhang, & Wang, 2018).

2. Material and methods

2.1. Literature search strategy

This study was done according to the PRISMA checklist (Moher et al., 2015) and a priori methods detailed in our protocol registered in PROSPERO database (CRD42019116442). We identified cross-sectional and longitudinal studies published between January 1, 2009 and 31st December, 2018, reporting the prevalence of depression among university students in LMICs. We searched three databases PubMed, Web of Science (including Medline, web of science core databases) and WHO Global Health Library. These databases were searched using a pre-tested search strategy comprising of three main concepts; university/college students, prevalence of depression, and low and middle income countries. Complete search strategy is available in supplemental Table.

2.2. Study selection criteria

Inclusion criteria were (a) Studies reporting prevalence of depression among university students; (b) Studies conducted in LMICs as defined by World Bank (World Bank, 2018); (c) Cross-sectional or longitudinal studies (baseline data); (d) English language studies and (e) Study sample size ≥ 500 . Exclusion criteria were studies reporting other study designs such as Randomized Controlled Trials (RCTs), case control studies, reviews (narrative and systematic), conference proceedings, case reports, qualitative studies, editorials, opinion papers, and letters.

2.3. Screening bibliographic record and data extraction

The database searches were conducted by the primary author (PA) from 17th to 20th January 2019. After deletion of duplicate records using Endnote software, two authors (PA and SN) independently screened all the titles and abstracts against the eligibility criteria. Any disagreements regarding inclusion for full-text screening were resolved through discussion with a third reviewer (AW). Thereafter, two authors (PA and SN) independently reviewed the full-texts of all included articles. Disagreements were discussed with third author (AW) to achieve consensus. Two authors (SN & PA) extracted data from the included articles while working independently from each other. Before starting the data extraction, both authors extracted data from three articles independently to establish inter-rater reliability. We found good inter-rater reliability between the two reviewers ($k=0.70$).

Using a standardized form, we extracted data pertaining to following characteristics of included studies: geographical location of the studies, mean age of sample, sample size, number and percentage of female participants, education level, study design, region and country, instrument used to screen for depression, specific diagnostic criteria or screening instrument cutoff, sampling procedures and prevalence of depression.

2.4. Quality assessment

Risk of bias in the included studies was assessed using a modified version of Newcastle-Ottawa scale (Stang, 2010). It assesses studies against following matrices: appropriate sample size, sample representativeness, comparability between respondents and non-respondents, ascertainment of depression and quality of descriptive statistics reporting. For each criterion, a score of one was assigned if “yes” was the response. Score on all items was summed together to generate a study specific global score. Studies were categorized to be at a low risk of bias (≥ 3 points) or a high risk of bias (< 3 points) (Rotenstein et al., 2016).

2.5. Statistical analysis

Meta-analysis was conducted using Comprehensive Meta-analysis Software (v. 3.0) (Borenstein, Hedges, Higgins, & Rothstein, 2013). Descriptive statistics pertaining to prevalence of depressive

symptoms and its overall severity were extracted. Studies were assessed based on methodological and statistical heterogeneity. Due to significant heterogeneity, data was pooled using random effects model and forest plots were generated displaying pooled prevalence with 95% confidence intervals. Standard χ^2 tests, Tau² and the I² statistic were used to assess between-study heterogeneity (Higgins & Thompson, 2002; Higgins, Thompson, Deeks, & Altman, 2003). I² was presented as the percentage of variability in prevalence estimates due to heterogeneity rather than sampling error, or chance, with values $\geq 75\%$ indicating considerable heterogeneity (Higgins & Thompson, 2002; Higgins et al., 2003). Sensitivity analysis involving single study “knock out” approach was used to ascertain contribution of specific studies on the pooled prevalence.

Publication bias was assessed by visual inspection of the funnel plot and Egger’s tests (considered significant at $p < 0.1$). In order to explore heterogeneity among studies, we used two approaches. For categorical moderators, we employed subgroup analyses using a mixed effects model. For quantitative moderators presented in ten or more studies, we employed meta-regression analyses. Subgroups were conducted by field of study, geographical region, depression screening tool, sampling technique and level of education. Meta regression with maximum likelihood method and random effects was conducted to determine effect of age, sample size, percentage of females, year of publication and quality assessment score on the pooled prevalence. To ensure appropriate statistical power, we conducted subgroup analysis when subgroups were reported in at least four studies (Fu et al., 2011). While meta-regression analysis were run for moderators reported in at least ten studies (Higgins & Green, 2011). All statistical tests were 2-sided and p-values < 0.05 was considered statistically significant.

3. Results

3.1. Study selection process

Our database searches yielded 2,561 research studies. After removal of 419 duplicates, 2,142 titles and abstracts remained for screening against inclusion and exclusion criteria. After the screening process, a total of 149 full texts were found eligible for further scrutiny. A total of 112 full texts were excluded in this stage because of following reasons; (a) sample size < 500 ($n=58$); (b) articles in language other than English ($n=20$); (c) outcomes other than depression ($n=19$); (d) study sample drawn from non-educational settings ($n=13$) and (e) overlapping datasets ($n=2$). A total of 37 full texts were included in both the qualitative and quantitative synthesis.

3.2. Study characteristics

Table 1 summarizes the basic characteristics of included studies. In total, 37 studies involving 76,608 individuals from 20 countries were included in the analysis (Figure 1). The median number of participants per study was 1,092 (range, 506-10,140). There were 36 cross-sectional studies ($n = 75993$) and one longitudinal study ($n = 615$) (Table 1), fifteen of (40.5%) them were conducted with medical students only and 22 (59.5%) included students from other fields. Of the 37 studies, 26 were conducted in Asia and 11 were conducted in other regions. A higher proportion of studies (27; 73%) took place in upper middle income countries whereas low income countries contributed a very small number of studies (10; 27%).

The included studies used a variety of self-reporting screening tools to assess depression; 10 studies used Beck Depression inventory (Beck A T, Ward C, & Mendelson M, 1961), 8 studies used Center of Epidemiological Scale for Depression (CES-D) (Radloff L S, 1977), and 5 used Patient Health Questionnaire (PHQ-9) (Kroenke, Spitzer, & Williams, 2001). Only one study used a structured interview tool for diagnose of depression.

3.3. Prevalence of depression in university students in LMICs

The pooled prevalence of depression among university students was 24.4% (95% CI, 19.2% to 30.5%). There was significant evidence of between-study heterogeneity ($I^2=99.65\%$, $Q=10,194.99$, $p < 0.001$) (Figure 2). The prevalence estimates reported by the individual studies ranged from 2.9% to 71%.

3.4. Subgroup analyses

No statistically significant differences in prevalence estimates were noted between medical students and students from other majors (test for subgroup differences, $Q = 0.33$, $p = .56$) or graduate and undergraduate students (test for subgroup differences, $Q = 1.2$, $p = .55$). Prevalence estimates from studies having a random sample did not significantly differ from estimates of studies having a non-random sample (test for subgroup differences $Q = 1.12$, $p = .29$).

The prevalence of depression among students did not differ across geographical regions ($Q = 2.77$, $p = .60$) or economic classification ($Q=3.71$, $p= 0.16$). Regarding the prevalence of depression according to depression screening tool, the pooled prevalence varied greatly among tools: for BDI 22.2% (95% CI, 14-33.3), CES-D 31.22%, (95% CI,19.6-45.9), PHQ-9 12.2 (95% CI, 5.9-23.5), and 29.8 (95% CI, 16.1-48.3) for other tools, however difference was not statistically different (test for subgroup differences, $Q = 13.68$, $p = .19$). (Table 2).

3.5. Meta regression analysis

Multivariate meta-regression analysis was conducted to explore the effect of mean age of participants, percentage of females with depression, sample size, quality assessment score and publication year on potential heterogeneity among studies. Table 3 shows the results of meta-regression analysis. None of the variables had significant influence on the mean prevalence ($p= 0.67$).

3.6. Sensitivity analysis

Sensitivity analysis did not indicate any changes in the mean prevalence when individual studies were removed from the meta-analysis.

3.7. Assessments of publication bias

Visualization of funnel plot and assessment of Egger's regression statistic (Figure 3) did not reveal any significant publication bias ($p=0.69$).

3.8. Quality assessment

In general, most of the included studies were of fairly high quality, with a low risk of bias. Mean quality score was 4.1 out of 5, with only two studies with a score <3 points. Out of 37 studies, 35 used a standard cut-off score of valid and reliable measure to screen for depression, while 30 studies included a representative sample of students. Fourteen studies did not include information on comparability between respondents and non-respondent. Newcastle-Ottawa score for all individual studies has been shown in supplementary materials (See supplemental Table 2).

4. Discussion

This systematic review and meta-analysis of 37 studies involving 76,608 university students in 20 countries demonstrated that 24.4% (95% CI: 19.2% to 30.5%) of university students were experiencing symptoms of depression. This review addresses an important paucity in evidence synthesis efforts because there are very few systematic reviews and meta-analyses on the prevalence of depression among university students in LMICs.

These findings are alarming given the observed relatively high prevalence in many LMICs and that depression has been linked to adverse effects on educational attainment, work productivity and employment (Breslau et al., 2008; Lee et al., 2009), all related to any country's economic growth. More importantly, depression increases the risk of suicide and risk for future depressive episodes (Clarke & Currie, 2009). Depression may also lead to substance use and other comorbid health issues (Weitzman, 2004). Large number of students experiencing depressive symptoms may associated with cultural factors

where high academic achievement is valued and determines not just future employment but the status of the individual within family and community (Dundes, Cho, & Kwak, 2009). Parental, societal expectations and immensely competitive environment at most of higher education institutes, with little to no emotional/ psychological support put students under huge pressure (Tan & Yates, 2011; Waqas et al., 2015). Curriculum does not focus on important life skills such as stress management and thus, most of the students continue to suffer in silence.

Our findings are consistent with the existing reviews reporting overall prevalence of depression among university students (30%) (Ibrahim et al., 2013) and are also consistent with the recent global prevalence estimates of 27% for medical students (Rotenstein et al., 2016). No differences were found in the prevalence of depression between students from medical and other majors, and no gender differences in prevalence were evident. . Some studies, however, suggest that medical students experience more depressive symptoms as compared to students from other majors due to the tough studies and schedules (Lei et al., 2016). This difference in findings might be explained as the university students study a variety of majors, they might be less satisfied and less confident about the future employment prospects than medical students who have a clearer career path after graduation.

In addition, some studies reported higher prevalence of depression among female students. We did not observe significant effect of gender in prevalence of depression. Previous reviews of university students also indicated that estimates did not differ by gender (Lei et al., 2016; Rotenstein et al., 2016). This might be attributed to the recently increasing opportunities and higher enrollment rates of females in higher education even in LMICs, which indicates that the barriers to female higher education are being overcome gradually.

A substantial heterogeneity was observed in overall analysis, and only a small part of it was explained by subgroups analyses. This can be attributed to diversity in samples in terms of number of students, gender ratio, socio-economic status of students, education systems, socio-economic and socio-political conditions of the countries. Although we included studies with an adequate sample size (≥ 500), there was a huge variation in sample sizes across studies. Moreover, different studies used different screening tool, and sometimes even different cut-offs of same screening tool. Our subgroup analysis and meta-regression analyses, revealed statistically non-significant differences among different subgroups. However, it is important to remember that subgroup analysis in meta-analytical studies are observational in nature and therefore, must be interpreted with caution.

In this systematic review, low income countries provided a small proportion of studies (only 10%). This indicates paucity of literature from a large number of countries that are facing adverse economic and socio-political conditions.

More methodologically rigorous studies with large, representative samples using valid and reliable tools are required to get accurate estimates of depression among university students, particularly in low income countries. Future studies should also focus on the risk factors and causes of depression. Intervention programs tailored to the needs of university students need to be tested and implemented. Such programs can be integrated in to the existing students' services where available to reduce barriers to access mental health services.

This study has several main strengths. First, we included recent, large sample studies to provide a reliable estimate of depression among university students. Second, our study is the first to investigate the prevalence of depression among university students in LMICs. Third, we conducted meta-analysis to provide an overall estimate of the depression prevalence across LMICs with available data.

This study also has a few limitations. First, studies included in this review were diverse in design, screening tool, sample size and population. This introduced substantial heterogeneity which could not be accounted for in subgroup analyses. Second, a majority of the studies included in this review employed

self-reporting measures. These self-reporting measures differ largely in their psychometric properties. These just serve as screening tools and do not provide a clinical diagnosis. Third, we reviewed studies published during last ten years, and could not examine the time trends in prevalence of depression in university students. Lastly, restriction to studies in English language is another important limitation of this review.

In conclusion, in this systematic review and meta-analysis, the summary estimate of the prevalence of depression among university students in LMICs was 24.4%, with large variations in the prevalence among studies. Most of the current studies are based on non-representative and small study samples. Further research is needed with large, representative samples, valid and reliable tools to explore risk and protective factors for depression and to identify strategies and intervention to manage this huge burden of depression.

Authors' contributions

All authors contributed equally to the study concept and design. PA, AW and SN performed the article search and data extraction. PA, AW and YL analyzed the data, under supervision of YW. All authors contributed to the interpretation of the results. PA drafted the initial version of the manuscript in support with YW, ML, AW & SN. All authors approved the final version of the manuscript.

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Table 1. Characteristics of the 37 included studies from low and middle income countries

Source	Study design	Level of education	Country	Field of study	Instrument & cutoff	Sample size	Sampling technique	Age, Mean (SD)	Females, No. (%)
1. Almhdawi et al. (2018)	Cross-sectional	Undergraduate	Jordan	Other	DASS-21 ≥ 10	838	Non-random	21.3 (1.8)	648 (77.3)
2. Amarasuriya, Jorm, and Reavley (2015)	Cross-sectional	Undergraduate	Sri Lanka	Other	PHQ-9 ≥ 10	4303	Non-random	NR	2986(69.4)
3. Angkurawaranon et al. (2016)	Cross-sectional	Undergraduate	Thailand	Medicine	PHQ-9 ≥ 10	1014	Non-random	20.8 (1.5)	538 (53)
4. Arslan, Ayranci, Unsal, and Arslantas (2009)	Cross-sectional	Mixed	Turkey	Other	BDI ≥ 11	822	Random	20.82 (1.83)	445 (54)
5. Bhandari et al. (2017)	Cross-sectional	Undergraduate	Nepal	Other	PHQ-9 ≥ 10	937	Random	21.01 (2.18)	511 (54.6)
6. Chen et al. (2013)	Cross-sectional	Mixed	China	Other	BDI ≥ 14	5245	Random	21.3 (2.2)	2682 (51)
7. Deb et al. (2016)	Cross-sectional	Graduate	India	Other	USDI NR	717	Random	21-26 years	315 (44)
8. Ediz, Ozcakir, and Bilgel (2017)	Cross-sectional	Undergraduate	Turkey	Medicine	BDI ≥ 13	928	Non-random	1.99 (2.37)	458 (49.4)
9. Falavigna et al. (2011)	Cross-sectional	Undergraduate	Brazil	Other	BDI ≥ 15	1180	Random	17-35	(746,63.2)
10. Gunay, Akpınar, Poyrazoglu, and Aslaner (2010)	Cross-sectional	Mixed	Turkey	Other	BDI ≥ 17	1003	Random	20.3(1.8)	496(49.4)

11. Ibrahim, Kelly, and Glazebrook (2012)	Cross-sectional	Undergraduate	Egypt	Other	ZDS-SF ≥ 10	988	Random	9.3 (1.8)	475(48.1)
12. James et al. (2017)	Cross-sectional	Undergraduate	Nigeria	Medicine	HADS-D ≥ 8	635	Random	23.91(3.67)	264 (42.4)
13. Kunwar, Risal, and Koirala (2016)	Cross-sectional	Graduate	Nepal	Medicine	DASS-42 ≥ 10	538	Non-random	NR	280(52)
14. Kongsomboon (2010)	Cross-sectional	Graduate	Thailand	Medicine	HRSRS ≥ 25	692	Random	NR	437(63.2)
15. Lazarevich et al. (2018)	Cross-sectional	Undergraduate	Mexico	Other	CES-D ≥ 16	1104	Non-random	19.6(2.4)	659(59.7)
16. (Li et al., 2016)	Cross-sectional	Undergraduate	China	Medicine	WHO-CIDI 3.0	1843	Random	21.3(1.6)	601(32.6)
17. Lowe, Lipps, and Young (2009)	Cross-sectional	Undergraduate	West indies	Other	BSD ≥ 21	690	Non-random	23.4 (7.4)	502 (73)
18. Mayer et al. (2016)	Cross-sectional	Undergraduate	Brazil	Medicine	BDI ≥ 10	1350	Non-random	22.8	714(52.89)
19. Minning et al. (2010)	Cross-sectional	Mixed	China	Other	CES-D ≥ 16	1178	Non-random	NR	354 (18.4)
20. Musumari et al. (2018)	Cross-sectional	Undergraduate	Thailand	Other	PHQ-9 ≥ 10	800	Non-random	18-24	405 (50.6)
21. Ngin et al. (2018)	Cross-sectional	Undergraduate	Cambodia	Other	CES-D ≥ 16	1359	Random	21.3 (2.3)	669(49)
22. Nguyen, Nguyen, Pham, Pham, and Nakamura (2018)	Cross-sectional	Undergraduate	Vietnam	Medicine	CES-D ≥ 16	1319	Non-random	NR	948(71.9)

23. Oyekcin, Sahin, and Aldemir (2017)	Cross-sectional	Mixed	Turkey	Other	BAPI NR	4430	Non-random	21.8 ((3.7)	2361 (53.3)
24. X. F. Pan et al. (2016)	Cross-sectional	Undergraduate	China	Medicine	BDI ≥ 14	9010	Non-random	20.7 (1.6)	5494(61)
25. Perveen, Kazmi, and ur Rehman (2016)	Cross-sectional	Undergraduate	Pakistan	Medicine	QIDS ≥ 10	1000	Non-random	NR	569 (57)
26. (Peltzer, Pengpid, & Tiembre, 2013)	Cross-sectional	Mixed	Ivory Coast	Other	CES-D ≥ 16	824	Random	23.7 (2.7)	412(50)
27. (Phimarn, Kaewphila, Suttajit, & Saramunee, 2015)	Cross-sectional	Undergraduate	Thailand	Medicine	CES-D ≥ 22	1421	Non-random	20 (0.95)	1130 (80)
28. Ristic-Ignjatovic et al. (2013)	Longitudinal	Undergraduate	Serbia	Medicine	BDI ≥ 10	615	Non-random	23.60(1.54)	375 (61)
29. Shamsuddin et al. (2013)	Cross-sectional	Mixed	Malaysia	Other	DASS-21 ≥ 10	506	Non-random	20.80 (1.57)	280 (55.3)
30. Shi, Liu, Wang, and Wang (2016)	Cross-sectional	Graduate	China	Medicine	CES-D ≥ 16	2925	Non-random	21.65(1.95)	1897(64.85)
31. L. Sun et al. (2011)	Cross-sectional	Undergraduate	China	Medicine	BDI ≥ 10	10140	Non-random	19.63 (1.28)	5460 (54)
32. X. J. Sun, Niu, You, Zhou, and Tang (2017)	Cross-sectional	Undergraduate	China	Other	BDI ≥ 14	5989	Random	20.85(0.58)	2792 (46.6)
33. Torres et al. (2017)	Cross-sectional	Undergraduate	Ecuador	Other	PHQ-9 ≥ 10	1092	Non-random	18.3 (1.1)	586(53.7)

34. Vargas, Talledo-Ulfe, Heredia, Quispe-Colquepisco, and Mejia (2018)	Cross-sectional	Undergraduate	Peru	Medicine	Zung-SDS NR	1922	Non-random	Range 18–22, Median 20	1047 (54.5)
35. Simic-Vukomanovic et al. (2016)	Cross-sectional	Graduate	Serbia	Other	BDI ≥ 10	1940	Random	21.04(2.23)	1259(65.2)
36. Xu et al. (2014)	Cross-sectional	Undergraduate	China	Nursing	CES-D ≥ 16	729	Random	16-25	661 (86.6)
37. Yu et al. (2015)	Cross-sectional	Undergraduate	China	Other	BDI ≥ 5	4582	Random	20.79(1.5)	2283 (50)

Abbreviations: BDI, Beck Depression Inventory; BDI-SF, BDI Short Form; BSI-DEP, Brief Symptom Inventory Depression; BSD, Brief Screen for Depression , CES-D, Center for Epidemiological Studies Depression Scale; DASS, Depression Anxiety Stress Scale; DSM-IV, Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition; HAM-D, Hamilton depression scale; HADS-D, Hospital Anxiety and Depression Scale; MINI, Mini International Neuropsychiatric Interview NR, not reported; PHQ-9, 9-item Patient Health Questionnaire; USDi, University Student Depression Inventory; ZDS-SF, Zagazig Depression Scale; Zung-SDS, Zung Self-Rating Depression Scale; Zung-SF, Zung-SDS Short Form

Table 2. Subgroup analysis of depression among university students based on study characteristics of 37 studies from 20 low and middle income countries

Group	Subgroup	No. of Studies	Prevalence (95% CI)	I ²	Q	p
Study design	Cross-sectional	36	24.4 (19.1-30.7)	99.65	0.01	0.92
	Longitudinal	1	22.8 (4.3-66.1)	0		
Level of education	Graduate	5	32.9 (17.7-52.8)	99.66	1.2	0.55
	Mixed	7	24.6 (14-39.5)	99.42		
	Undergraduate	25	22.8 (17-30)	99.65		
Study discipline	Medicine	15	22.4 (14.9-32.2)	99.66	0.33	0.56
	Other	22	25.8 (18.7-34.5)	99.66		
Sampling technique	Non-random	21	27 (19.7-36.3)	99.68%	1.12	0.29
	Random	16	21(14.1-30.1)			
Screening instrument	BDI	10	22.2 (14-33.3)	99.69	13.68	0.19
	BDI-II	2	22.6 (7.8-50.4)	99.75		
	CES-D	8	31.2 (19.6-45.9)	99.60		
	DASS-21	2	49.6 (22-77.5)	98.69		
	DASS-42	1	29.9 (6.8-71.5)	0		
	HRSRS	1	8.4 (1.5-35.2)	0		
	HADS	1	20.9 (4.3-60.9)	0		
	PHQ-9	5	12.2 (5.9-23.5)	98.06		
	QIDS	1	51.5 (15.4-86.1)	0		
	Zung-SDS	1	13.5 (2.6-47.6)	0		
	Other	5	29.8 (16.1-48.3)	99.71		
Income levels	Low income	2	25.3(8.2-56.2)	92.79	3.71	0.16
	Lower middle	8	36.3(22.7-52.6)	99.65		
	Upper middle	27	21.3 (15.9-28)	99.67		
Region	Africa	3	34.2(14.6-61.2)	99.66	2.77	0.60
	Asia	26	24.9(18.5-32.6)	99.71		
	Europe	2	23.2 (7.2-54.1)	0		
	South America	5	15.7 (7.3-30.6)	99.32		
	The Caribbean	1	39 (8.5-81.4)	0		

Abbreviations: BDI, Beck Depression Inventory; CES-D, Center for Epidemiological Studies Depression Scale; DASS, Depression Anxiety Stress Scale; HADS-D, Hospital Anxiety and Depression Scale; PHQ-9, 9-item Patient Health Questionnaire; QIDS, Quick Inventory of Depressive Symptomatology; Zung-SDS, Zung Self-Rating Depression Scale

Table 3. Meta-Regression analysis for the prevalence of depression in university students on the basis of study characteristics from 37 studies from 20 low and middle income countries

Covariate	Coefficient	S.E	95% CI	Z-value	p
Intercept	-27.74	151.21	-324.1168-268.6368	-0.18	0.85
Mean age	0.1765	0.14	-0.1174-0.4704	1.18	0.24
Year of publication	0.0108	0.07	-0.1357-0.1572	0.14	0.88
Quality assessment score	0.2816	0.24	-0.1987-0.7618	1.15	0.25
% of females with depression	0	0.00	-0.0003-0.0002	-0.34	0.73

$R^2 = 0.08$, $Q = 2.34$, $df = 4$, $p = 0.67$, $n = 37$ studies

Supplemental Table 1: Search Strategy

Key terms	Search term
University students	college students” OR “university students” OR “undergraduate students
Depression	depression OR “Depressive symptoms” OR “Major Depression” OR “Major Depressive Disorder” OR “Depressive Disorder” OR Depressed OR Sadness OR depress*
Prevalence	Prevalence OR frequency OR epidemiology OR risk
Low and Middle Income Countries	(“Middle income country” OR “Middle income countries” OR “low income countries” OR “low income country” OR LMIC OR “developing world” OR “developing country” OR “developing countries” OR Afghanistan OR Albania OR Algeria OR “American Samoa” OR Angola OR Armenia OR Azerbaijan OR Bangladesh OR Belarus OR Belize OR Benin OR Bhutan OR Bolivia OR “Bosnia and Herzegovina” OR Botswana OR Brazil OR Bulgaria OR “Burkina Faso” OR Burundi OR “Cabo Verde” OR Cambodia OR Cameroon OR “Central African Republic” OR Chad OR China OR Colombia OR Comoros OR “Congo Dem. Rep” OR “Congo, Rep” OR “Costa Rica” OR “Côte d'Ivoire” OR” Cuba” OR Djibouti OR Dominica OR “Dominican Republic” OR Ecuador OR “Egypt, Arab Rep” OR “El Salvador” OR “Equatorial Guinea” OR Eritrea OR Ethiopia OR Fiji OR Gabon OR “Gambia The” OR Georgia OR Ghana OR Grenada OR Guatemala OR Guinea OR “Guinea-Bissau” OR Guyana OR Haiti OR Honduras OR India OR Indonesia OR “Iran, Islamic Rep” OR Iraq OR Jamaica OR Jordan OR Kazakhstan OR Kenya OR Kiribati OR “Korea, Dem. People's Rep” OR Kosovo OR “Kyrgyz Republic” OR “Lao PDR” OR Lebanon OR Lesotho OR Liberia OR Libya OR “Macedonia, FYR”OR Madagascar OR Malawi OR Malaysia OR Maldives OR Mali OR “Marshall Islands” OR Mauritania OR Mauritius OR Mexico OR “Micronesia, Fed. Sts” OR Moldova OR Mongolia OR Montenegro OR Morocco OR Mozambique OR Myanmar OR Namibia OR Nauru OR Nepal OR Nicaragua OR Niger OR Nigeria OR Pakistan OR “Papua New Guinea” OR Paraguay OR Peru OR Philippines OR Romania OR “Russian Federation” OR Rwanda OR Samoa OR “São Tomé and Príncipe” OR Senegal OR Serbia OR “Sierra Leone” OR “Solomon Islands OR Somalia OR “South Africa” OR “South Sudan” OR “Sri Lanka” OR “St. Lucia” OR “St. Vincent and the Grenadines” OR Sudan OR Suriname OR “Swaziland Syrian Arab Republic” OR Tajikistan OR Tanzania OR Thailand OR “Timor-Leste” OR Togo OR Tonga OR Tunisia OR Turkey OR Turkmenistan OR Tuvalu OR Uganda OR Ukraine OR Uzbekistan OR Vanuatu OR “Venezuela, RB” OR Vietnam OR “West Bank and Gaza” OR “Yemen, Rep” OR Zambia OR Zimbabwe))

Supplemental Table 2: Newcastle-Ottawa risk of bias scoring for individual studies

Source	Representativeness	Sample size	Non-respondents	Ascertainment of depression	Descriptive statistics	Total
Almhdaw,2018	1	1	1	1	1	5
Amarasuriya,2015	1	1	1	1	0	4
Angkurawaranon,2016	0	1	1	1	1	4
Arslan, 2009	1	1	1	1	1	5
Bhandari,2017	5	1	1	1	1	5
Chen, 2013	1	1	1	1	1	5
Deb, 2106	1	1	0	0	0	2
Ediz, 2017	0	1	0	1	1	3
Falavigna, 2011	0	1	0	1	1	3
Gunay, 2010	1	1	1	1	1	5
Ibrahim, 2012	1	1	1	1	1	5
James, 2017	1	1	0	1	1	4
Kongsomboon, 2010	1	1	1	1	0	4
Kunwar, 2016	1	1	1	1	1	5
Lazarevich, 2018	0	1	1	1	1	4
Li, 2016	0	1	1	1	1	4
Lowe, 2009	0	1	0	1	1	3
Mayer, 2016	1	1	0	1	1	4
Minning, 2010	1	1	0	1	0	3
Musumari, 2018	1	1	1	1	1	5
Ngin, 2018	1	1	0	1	1	4
Nguyen, 2018	1	1	1	1	1	5
Oyekcin, 2017	1	1	0	0	0	2
Pan, 2016	1	1	1	1	1	5
Parveen, 2016	1	1	0	1	0	3
Peltzer, 2013	1	1	1	1	1	5
Phimarn, 2015	1	1	1	1	1	5

Ristić-Ignjatović, 2013	0	0	1	1	0	2
Shamsuddin, 2013	1	1	1	1	1	5
Shi, 2016	1	1	1	1	1	5
Sun, 2011	1	1	0	1	1	4
Sun, 2017	1	1	1	1	1	5
Torres,2017	1	1	0	1	1	4
Vargas,2018	1	1	0	1	1	4
Simic-Vukomanović 2016	1	1	1	1	1	5
Xu,2014	1	1	0	1	1	4
Yu,2015	1	1	1	1	1	5

